Journal of the Society of Arts.

FRIDAY, SEPTEMBER 13, 1861.

INTERNATIONAL EXHIBITION OF 1862.

The Council beg to announce that the Guarantee Deed is now lying at the Society's House for signature, and they will be much obliged if those gentlemen who have given in their names as Guarantors, will make it convenient to call there and attach their signatures to the Document. Signatures for sums amounting in the aggregate to £428,600, have been attached to the Deed.

THE EXHIBITION OF 1862 AND RAILWAY COMMUNICATION.

Mr. Robert K. Bowley, the General Manager of the Crystal Palace, has lately issued a paper on the importance of affording to the working classes throughout the kingdom the utmost facility of access to the Exhibition. He refers to the paper read before the Society, by Mr. Wm. Hawes, at the end of last Session, in which it will be recollected that the question of the adoption of a low price of admission, and its probable effect in producing a large attendance of the really working classes, was discussed. Mr. Bowley says :—

"Some of the statistics of Mr. Hawes had an important bearing upon this question, as they showed that while the attendance at the One Shilling or One Franc rate and upwards, at Paris and at London, bore a near approximation to the population of each capital, yet the Paris Exhibition had the advantage of 2,182,433 visitors who were admitted at a charge of 4 *sous* each, thus proving, what of course may be held to be self-evident, that to induce the attendance of the really working classes, very moderate outlay is essential.

"It is not, however, to the price of admission that attention should be solely directed, but to that more important because far wider question, the difficulty of access by the working classes to the Exhibition.

"No Exhibition in England can be properly developed which does not afford the opportunity for day excursions from all parts within reach of six or seven hours railway travel. This the Exhibition of 1862, with its present prospects will fail to effect, and it may safely be affirmed that this alone will prevent many hundreds of thousands, probably millions, from visiting it.

"It is not that railway access from all the great lines, north, south, east, and west, will not be nearly available, as the completion of the West-end extension line from Wandsworth to Kensington will bring railway communication with all the lines radiating from the metropolis to within a mile and a quarter of the Exhibition building prior to May, 1862. As, however, it is understood that the great companies forming this important junction intend building their main station in the Hammersmith-road, adjoining the bridge which carries the road over Punch's line, and as this proposed station is above a mile and three quarters from the main entrance to the Exhibition building,* it must obvious to all that, for the purposes of day excursions from distant places, it is practically useless.

"It should be borne in mind that no advantage is afforded by the Victoria station for excursion day traffic, as that is also above a mile and three-quarters (1 m. 6 flgs. 82 yds.) distant from the Exhibition; it is, therfore, as useless as the Hammersmith-road."

The author points out other serious objections, which, he says, would prevent Victoria station becoming the general railway route to the Exhibition, for the approaches to it across the new railway bridge are too limited and inconvenient to afford proper facilities for extensive day excursion traffic from various parts of the kingdom. He goes on to say :—

"It need scarcely be pointed out that to have a gap of more than a mile and a half between the railway terminus and the Exhibition building must be entirely destructive to day excursion traffic. At a period like that of a London International Exhibition, and at a station some miles away from the heart of the metropolis, like that proposed in Hammersmith-road, not the least dependence could be placed upon road conveyance to the Exhibition; what little existed would be uncertain in the extreme, and exorbitant in charge, particularly as a heavily taxed turnpike intervenes between the two points.

"It being thus certain that day excursions from the main lines of railway will be practically unavailable, under existing or present contemplated circumstances, it becomes a serious inquiry for the interests of the Exhibition, Is there any remedy to this great drawback to its success?

"Fortunately (he says) that remedy does exist. It is attainable at a moderate and amply remunerative cost, and it is capable of accomplishment before the opening of the Exhibition on the first May next. A short branch line, of a mile-and-a-quarter only in length, may be made the direct line from the Kensington and Wandsworth Junction, between Earl's-court and North-end, to within a few hundred feet of the Exhibition main building, which would fulfil all the requirements of the case. No cuttings, no heavy embankments are required. It would run nearly on the level. Four lines of railway, perhaps with a loop or circle at the Cromwell-road end, so as to avoid shunting or drawing back the carriages, would suffice. Temporary wooden sheds or stations are all that would be at present needed. If this is managed economically it must give a handsome return for outlay.

"A line thus formed would bring to the doors of the Exhibition, traffic from all the principal railways. In fact it would bring all the railway service of this greatly developed railway country into one focus, and that focus the great attraction of the day, the International Exhibition. Who would be bold enough to place a limit upon the numbers of the working classes who, from all our great manufacturing and other districts, would attend the Exhibition, provided they could do it by day excursions, so arranged as not to entail upon them the expense and difficulty of lodging for even one night in London, at such an expensive time as 1862 will be.

"With the working man, time is money. If he has to spend three days in going and returning, and visiting the Exhibition, how few, comparatively, can indulge the luxury.

"It is difficult, however, to over-estimate the numbers which, under favourable circumstances, might be brought from the densely-populated districts to visit the Exhibition. The last agricultural show at Leeds was visited by 77,000 persons in one day, the bulk of whom were carried into that town for the day by cheap excursions.

"If a little consideration is given to the immense population existing within six or seven hours' railway ride of South Kensington, it will be seen what an important bearing this question has on the probable success of the Exhibition. For instance, from Margate, Dover, Hastings, Brighton, Portsmouth, Southampton, and adjoining places on the South Coast and intermediate districts, the present third-class excursion rate varies from half-a-crown to three shillings and sixpence. Arrangements may be probably made between the railway companies and the Commissioners of the Exhibition, for a joint issue of day tickets

* 1 m. 6 flgs. 163 yds.

(as now existing at the Crystal Palace), including conveyance and admission, without any advance on these rates. The least reflection will show how wonderfully this traffic would be developed by the extension of railway access to the Exhibition itself.

"If the range is extended along the western lines it will be found that considerably beyond Exeter, nearly two hundred miles off, that Cardiff, with Merthyr and its neighbouring coal districts, that Monmouth and Hereford, on to Shrewsbury and Welshpool, up to Chester, with Liverpool and Manchester, and from thence by Halifax, Bradford, and Leeds, in a line to the Humber, comprising within it also the whole of the Eastern Counties Railway system, are within the limits of single day excursions. Thus, from this, which embraces the largest portion of the United Kingdom, a population of probably upwards of fifteen millions would be brought within range of a day's visit to the Exhibition of 1862. In no other country could such a practical illustration of the power acquired by facility of railway travel be given—in no other country could a great International Exhibition be held which would develop such results as that of 1862, provided only that due attention is paid to the excursion traffic.

"It may be argued that the limit of six or seven hours railway travelling is too distant for excursions. In an ordinary case this would be so, but on an occasion like the present it may be safely relied upon that the great Railway Companies would do all in their power to assist such distant traffic, as it must be obvious that the more they encourage the habit of travelling the better it must be for their several lines."

Passing from the consideration of long traffic to that of metropolitan and suburban traffic, the author says that, features of great interest are presented in connection with the suggested junction with the Exhibition. He refers to the distance between the Exhibition building and various places in the heart of London, such as the Post Office, (4 miles 50 yards), Islington, (4 miles 790 yards), the Blackwall Railway Station, (4 miles 1,450 yards), the only access from them to the Exhibition being through crowded thoroughfares. The remembrance of the uncertainty of conveyance, the increase of fares by the omnibus proprietors—still more probable now that the London omnibuses are in the hands of a great monopoly—would be fresh in the minds of all who watched the Exhibition of 1851. The author proceeds as follows:—

"As the population of London since that time has increased by half-a-million, and as the habit of residing within short distances outside the metropolis has also brought a large increase of inhabitants near to London, it may be fairly assumed that from these sources alone the main thoroughfares leading to the Exhibition will be far more crowded than they were eleven years since, and the expense and difficulty of road conveyance proportionably increased. How materially this difficulty would be lessened by the construction of the short branch of railway proposed, a glance at the map of London will show.

"From the eastern and northern districts considerable numbers would avail themselves of the North London line, commencing at Fenchurch-street.

"For the south-east of London, trains run from the Crystal Palace station to Wandsworth, stopping at nine intermediate stations, in forty-three minutes. The return third-class fare is 9d. Five minutes longer travelling, and a few pence extra cost, and hundreds of thousands of passengers might be carried over the junction to the Exhibition doors.

"If these two lines of railway which encircle London from east and west by northern and southern routes, could be brought close to the Exhibition, as proposed, immense relief must be given to the main road thoroughfares, and great additional facilities placed at the command of the inhabitants of London and its neighbourhood for visiting the Exhibition.

"There is still a third route which might be made available as a main route to the Exhibition. Should it be attainable, its importance cannot be over estimated.

"At the meeting of the Charing-Cross Railway, held on the 7th of August, Mr. Hawkshaw, the engineer to the line, stated 'he was willing to make the attempt to have the line open to Waterloo by the 1st of May, 1862, to meet the requirements of the Exhibition.'

"A continuance of the South Eastern from London-bridge to Waterloo, thence on by South Western to Wandsworth, crossing the Thames by the junction now forming, would (with the short line now advocated) form a line to the Exhibition from London-bridge, of less than eight miles in length, nearly as direct as that by road through Cannon-street, Fleet-street, Piccadilly, and Brompton-road. Should this line be capable of accomplishment—should the South Eastern and South Western Companies be disposed to co-operate in working it, it must be clear that the question of easy railway access to the Exhibition will meet with a happy solution.

"It is no answer to the arguments here adduced to say that because the Exhibition of 1851, without these additional facilities of travel, was a great success, and was visited by upwards of six millions of persons, therefore this additional and convenient mode of access is not required. The only reasonable argument would be, if, despite these inconveniences, the visitors in 1851 were 6,000,000, how many are likely to attend in 1862, provided they are removed?

* * * *

"As somewhat in connection with this subject, it may not be out of place here to remark upon a growing necessity in the management of the Exhibition of 1862. It will not do to rely too much on the *prestige* of the 1851 Exhibition. In the years that have elapsed since then, much general experience has been acquired of the working of these institutions, a greater insight has been gained into the habits and inclinations of the people. It has become a recognised axiom in these undertakings that it is numbers which pay. The Exhibition of 1862 in its Art features will have a novelty of great interest to push it onwards, but this and other points of interest must be brought far more prominently and repeatedly under public notice than they have yet been. Far greater facilities now exist for this purpose than in 1850, but if they are not made use of the well-wishers of the Exhibition may find too late that to fully arouse public attention, continuous exertion and publicity are requisite.

The author urges the necessity of making immediate arrangements with the railways as to excursion traffic, and of arousing the interest of all classes of the community in the coming Exhibition.

"Set the example of originating Exhibition Visiting Clubs; enlist the co-operation of the clergy of all denominations; point out to the employers of labour how pleasant, and how profitable also, it will be to them to encourage, and, if necessary, to aid those dependent upon them in availing themselves of such an opportunity of witnessing the triumphs of industry and art; and above all, endeavour to lead those to whom the Almighty has in this world given wealth and influence, to assist their humble brothers and sisters to at least one day's enjoyment of the Exhibition of 1862."

If all this be done, Mr. Bowley does not hesitate to express his belief that the number of visitors to the Exhibition of 1851 may be doubled in 1862. He concludes by quoting from Mr. Hawes's paper above referred to:—

"The object of Exhibitions is to educate nations, not classes; it is not merely to amuse the rich, but to teach the people; not only to give information to the merchant and manufacturer to enable him to extend his works and increase his gains, but to show the people the progress of their rivals in trade and manufactures, that they may learn thereby in what manner best to exert their skill and intelligence."

BRITISH ASSOCIATION, 1861.

The following Paper was read before the Mechanical Section:—

FREIGHT AS AFFECTED BY DIFFERENCES IN THE DYNAMIC PROPERTIES OF STEAM SHIPS. By CHAS. ATHERTON, CHIEF ENGINEER, H.M. DOCKYARD, WOOLWICH.

The national importance of steam shipping is a theme which demands no demonstration, and any attempt to originate, promulgate, and popularise inquiry into the comparatively economic capabilities of the steam ship as devoted to the international conveyance and interchange of the products of nature and of manufacturing art, irrespective of its application as an engine of war, is a task which requires no laboured introduction in support of its being favourably received for consideration by an association devoted to the advancement of science.

The former papers on "Tonnage," "Steam Ship Capability," and "Mercantile Steam Transport Economy," which the author of this further communication has been permitted to present to the British Association, and which appear in the volumes of its Transactions for the years 1856, 1857, and 1859, were devoted to an exposition of the technicalities of the subject as respects the mutual quantitative relations which displacement, speed, power, and coal hold to each other in the construction and equipment of steam ships with a view to the realization of definite steaming results. So far, therefore, these investigations have had reference to the constructive equipment of steam ships, but the course of inquiry now submitted for consideration is intended to be a practical exposition of the extent to which the expense per ton weight of cargo conveyed is affected by the various conditions of size of ship, dynamic quality of hull with reference to type of form, weight of hull with reference to its build, the economic properties of the engines with reference to the consumption of fuel, and the steaming speed at which the service is required to be performed, all which circumstances respectively, and in their combinations, affect the economic capabilities of steam ships for the conveyance of mercantile cargo, and consequently freights charged, to an extent not publicly known, because hitherto not specially inquired into nor promulgated by the press, and which in the distinctive details above set forth do not appear to have been duly appreciated even by the parties most deeply concerned in the mercantile control and prosecution of steam shipping affairs. The aggregate expenses incidental to the prosecution of steam transport service must generally regulate the average rates of freight at which goods are conveyed; and seeing to what an extent the ultimate cost of manufactured goods is dependent on the cost of transport, often repeated as freight charges generally are in the various stages of transition of material from the raw to its manufactured condition, and its ultimate consumption as a manufactured article, it becomes evident that this investigation especially concerns the manufacturing interests of the country. Economy of price inducing quantity of consumption, is the characteristic feature of the manufacturing enterprise of the present day, and it is the absolute cost of goods which affects consumption, irrespectively of the various causes in detail by which the cost may have been enhanced. Under these circumstances, it is remarkable to what extent the manufacturing interests, though keenly alive to legislative imposts, whether foreign or domestic, affecting the cost of goods, and sensitively jealous of legislative interference in the control of labour, as affecting the cost of manufacture, pass wholly unheeded deficiencies and imperfections in the practical control of shipping with reference to freight charges, though equally affecting the ultimate price of manufactures. Such incongruity demonstrates the necessity for popular exposition and inquiry into the various circumstances and combinations of circumstances which directly affect the expenses incidental to the conveyance of merchandise by steam ships, and by which the rates of freight are in the aggregate necessarily regulated. Freight, therefore, is the text of the following discourse, to which attention is directed under the various aspects of steam ship construction and management, by which freight charge is affected, and which may be classified under 10 heads or sections, as follow:—

SECTION A.—FREIGHT, as affected by variations of the size of the ship by which the service is performed.

B.—FREIGHT, as affected by variations in the constructive type of form of the hull.

C.—FREIGHT, as affected by variations in the working economy of the engines, with reference to the consumption of coal.

D.—FREIGHT, as affected by variations in the constructive weight of the hull, with reference to its load displacement.

E.—FREIGHT, as affected by variations in the constructive type of form, combined with variations in the working economy of the engines.

F.—FREIGHT, as affected by variations in the size of ship, combined with variations in the constructive type of form, and in the working economy of the engines.

G.—FREIGHT, as affected by variations of the steaming speed at which it is required that the service shall be performed.

H.—FREIGHT, as affected by variations of the size of ship, combined with variations of speed.

I.—Freight, as affected by variations of the speed, combined with variations of the working economy of the engines.

K.—FREIGHT, as affected by variations of the speed, combined with variations in the type of form, working economy of the engines, and weight of hull.

It will be observed that it is not proposed to determine the actual amount of prime cost expenses incidental to the prosecution of steam ship enterprise, by which the scale of freight charge may be chiefly regulated, but it is proposed to demonstrate, with reference to a specified unit of performance, the ratio or comparative scale of cost, in which the prime cost expenses incidental to the conveyance of cargo per ton weight of goods conveyed on a given passage is, *cæteris paribus*, affected by each of the various circumstances or conditions set forth under the 10 different heads above referred to.

The fundamental consideration on which it is proposed to base this investigation is this, that, within moderate limits of variation, the investment incidental to the fitting out of steam ships for commercial transport service is approximately proportional to the quantity of shipping as measured by the constructors' load displacement of the ships, and the amount of working power employed as measured by the indicated horse power, also that the interest on investment, upholding of stock, and all other annual expenses incidental to the working of steam ships, such as coals, stores, and wages, harbour dues, insurance, and pilotage, are approximately proportional to such investment; and further, as the mercantile service of steam ships employed on a given station generally requires that their passages shall be periodical it is assumed in the following calculations that the number of passages made annually by each ship is the same in all the different vessels assumed to be employed on the same service and brought into comparison with each other.

It is particularly to be observed that these calculations and deductions of comparative freight charges are not of general application to different services, but have reference only to the special service which, as an example of the system of calculation for any service, has been adopted as the unit of performance, namely, the performance of a ship of 5,000 tons displacement, employed on a passage of 3,000 nautical miles and steaming at ten knots

per hour, the co-efficient of performance by the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. h.p.}} = C$, being C=250, and the consumption of coal being at the rate of 2lbs. per indicated horse-power per hour, which data have been assumed as the base of the following tabular statement, consisting of 19 columns, the purport of which is as follows:—

Column 1st.—Reference to divisions or sections of the subject under consideration.

2nd and 21st.—Designation of the vessel referred to in the various sections.

3rd.—Size of the ship as determined by displacement at the draft to which it is intended by the constructor that the ship shall be loaded.

4th.—Steaming speed at which the vessel is required to perform the passage.

5th.—Co-efficient of dynamic performance of the vessel by the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. h.p.}} = C$.

6th.—Consumption of coal per indicated horse power per hour expressed in lbs.

7th.—Co-efficient of dynamic duty with reference to coal consumed by formula $\frac{V^3 D^{\frac{2}{3}}}{W}$ W being the average consumption of coal expressed in cwts. per hour.

8th.—Power required to propel the vessel at the required speed expressed in indicated horse-power and calculated by the formula, indicated horse-power $= \frac{V^3 D^{\frac{2}{3}}}{C}$

9th.—Length of passage to be performed by the ship without re-coaling expressed in nautical miles.

10th.—Weight of hull, including all equipment complete for sea (exclusive of engines, coal, and cargo) taken at 40 per cent. of the load displacement.

11th.—Weight of engines and boilers in working order, including all equipment for sea, taken at the rate of 5cwts. per indicated horse-power.

12th.—Weight of coal required for the passage, calculated on the foregoing data.

13th.—Cargo, as determined by the load displacement less the weight of hull, engines, and coal.

14th.—Investment in the hull of the ship, including rigging, furnishing, and all other equipment complete for sea, taken at £50 per ton weight of hull.

15th.—Investment in the engines, including spare gear and all equipment for sea, taken at £15 per indicated horse-power.

16th.—Total investment in hull and engines.

17th.—Comparative rates of freight or ratios of cost expenses per ton of cargo, being proportional to the investment divided by the tons weight of cargo conveyed.

18th.—Ratios of cost expenses per ton of cargo, with reference to that incurred by ship A, taken as the unit of performance, and which is expressed by the number 100.

19th.—Ratios of cost expenses per ton of cargo with reference to the cost incurred by ship A taken as the unit of performance, and which is expressed by £1 per ton.

20th.—Comparative freight on 100,000 tons of goods, assuming the freight by ship A to be at the rate of £1 per ton of goods conveyed.

21st.—Designations of vessels refered to in the sections.

The table (next page) may be interpreted as follows:—

SECTION A.—Freight, as affected (*cæteris paribus*) by variations of the size of ship.

By reference to the table (next page) it will be observed that as the ship's size (column 3) is reduced from 5,000 tons displacement to 4,000 tons, the expenses per ton of cargo (column 17) become increased in the ratio of 49 to 51, that is, in the ratio of 100 to 104 (column 18), showing an increase of 4 per cent.; or, expressed in money, assuming £1 per ton to be the rate of freight by ship A, of 5,000 tons displacement, the rate by ship A_1, of 4,000 tons displacement will be £1 0s. 10d., and by following the table it appears that the rate of freight by ship A_2, of 3,000 tons, will, as compared with ship A, of 5,000, be increased 8 per cent., amounting to £1 1s. 8d. per ton.

The comparative freight charges on 100,000 tons of goods (column 20) by the vessels A, A_1, A_2, respectively would be £100,000, £104,000, and £108,000.

Thus, in a merely mechanical point of view, and irrespectively of various mercantile and nautical considerations which may limit the size of ships, we see the benefit of performing goods transport service by large vessels in preference to small ones, provided that adequate cargo be always obtained and that no delay be thereby incurred. But it is to be observed that if the 5,000 tons ship A, instead of being loaded with its full cargo of 2,395 tons, be loaded only with the quantity of cargo (1,878 tons) that could be carried by the 4,000 tons ship, A_1, the freight expenses per ton of cargo would, in this case, be enhanced in the proportion of 63 to 49, that is, in the proportion of 128 to 100, or 28 per cent., or, expressed in money in the proportion of £1 4s. 10d. to £1, the same being a higher rate by 24 per cent. than the freight charge at which the 4,000 tons ship, A_1, would perform the service. By pursuing the calculations from the data adduced by the table, it will be found that the economic advantage of the 5,000 tons ship A, as compared with the 4,000 tons ship, A_1, will be entirely sacrificed if its cargo be reduced from 2,395 tons to 2,305 tons, or be only 90 tons, or $3\frac{3}{4}$ per cent., deficient of its full load. Also, as compared with the ship A_2, of 3,000 tons, the advantage of the 5,000 tons ship A, will be lost if its cargo be reduced from 2,395 tons to 2,218, or be only 117 tons deficient of its full load.

Hence it appears that the superior economic capabilities of large ships in a mechanical point of view for the conveyance of goods, may, in a mercantile point of view, be very soon sacrificed by mismanagement in assigning larger vessels for the discharge of mercantile service than is demanded by the trade, notwithstanding the economic superiority of large ships when promptly and fully loaded.

SECTION B.—Freight, as affected (*cæteris paribus*) by variations in the constructive type of form of the hull.

The relative constructive efficiency of mercantile ships in a purely dynamic point of view, as respects type of form (irrespectively of materials and workmanship), is now generally recognised as being determined by their co-efficients (C) of dynamic performance, as deduced from actual trial of the ships, and calculated by the following formula $\frac{V^3 \quad D^{\frac{2}{3}}}{\text{Ind.h.p.}} = C$, which may be expressed as follows:—

Multiply the cube of the speed (V^3) by the cube root of the square of the displacement ($D^{\frac{2}{3}}$), and divide the product by the indicated horse-power (Ind. h. p.); the quotient will be the co-efficient (C) of dynamic performance.

To enter upon the various uses to which this formula is applied would be irrelevant to the matter now under consideration. Suffice it to say that the numeral co-efficient obtained as above set forth affords practically a means by which the mutual relations of displacement, power, and speed of a steam ship of given type of form, and of which the co-efficient is known, may (*cæteris paribus*) be deduced, and it affords a criterion indicating, whatever be the size of the ship, the constructive adaptation of its type of form for mechanical propulsion, as compared with other types of form tested by the same rule, the condition of the vessels as respects cleanness of immersed surface, stability, and other essential properties, being assumed to be the same; and we now proceed to show to what extent, under given conditions, freight per ton of goods conveyed is affected by variations of type of form, as represented by variations of the co-efficient of performance.

By reference to the table (Section B), it will be observed that as the co-efficient of dynamic performance is reduced from 250 to 150, the expenses become increased in the ratio of 100 to 132, or 32 per cent., or, assuming the freight by ship A, of which the co-efficient of dynamic performance is 250, to be at the rate of £1 per ton of cargo, the charge by ship B_1, of the same size, but of which the co-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			20	21
									Weight of				Investment.									
Reference.	Designation of Vessels.	Constructor's load displacement.	Steaming speed per hour.	Co-efficient of performance.	Coal per Indicated horse-power per hour.	Co-efficient of economic duty.	Power.	Passage.	Hull and its Equipment complete.	Engines and their equipment.	Coal for the passage.	Cargo.	Hull at £50 per ton weight.	Engines at £15 per Ind. h.p.	Total.	Comparative rates of expenses incurred per ton of cargo.	Comparative ratios, with reference to freight by ship A, taken at 100.	Comparative rates, with reference to freight by ship A, at £1 per ton weight.			Comparative freight charges on 100,000 tons of goods,	Designation of Vessels.
				$\frac{V^3\ D^{\frac{2}{3}}}{\text{Ind. h.p.}}$		$\frac{V^3\ D^{\frac{2}{3}}}{W.}$										Investment Cargo.						
Section.		Tons.	Knots.		Lbs.		Ind. h.p.	N. miles.	Tons.	Tons.	Tons.	Tons.	£	£	£		Ratios.	£	s.	d.	£	
A	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	A_1	4,000	10	250	2	14,000	1,008	3,000	1,600	252	270	1,878	80,000	15,120	95,120	51	104	1	0	10	104,000	A_1
	A_2	3,000	10	250	2	14,000	832	3,000	1,200	208	223	1,369	60,000	12,480	72,480	53	108	1	1	8	108,000	A_2
B	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	B_1	5,000	10	200	2	11,200	1,462	3,000	2,000	365	392	2,243	100,000	21,930	121,930	54	110	1	2	0	110,000	B_1
	B_2	5,000	10	150	2	8,400	1,950	3,000	2,000	487	522	1,991	100,000	29,250	129,250	65	132	1	6	5	132,000	B_2
C	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	C_1	5,000	10	250	3	9,333	1,170	3,000	2,000	292	470	2,238	100,000	17,550	117,550	52	106	1	1	2	106,000	C_1
	C_2	5,000	10	250	4	7,000	1,170	3,000	2,000	292	627	2,081	100,000	17,550	117,550	56	114	1	2	10	114,000	C_2
D	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	D_1	5,000	10	250	2	14,000	1,170	3,000	2,500	292	313	1,895	125,000	17,550	142,550	75	153	1	10	7	153,000	D_1
	D_2	5,000	10	250	2	14,000	1,170	3,000	3,000	292	313	1,395	150,000	17,550	167,550	120	245	2	9	0	245,000	D_2
E	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	E_1	5,000	10	200	3	7,467	1,462	3,000	2,000	365	588	2,047	100,000	21,930	121,930	59	120	1	4	0	120,000	E_1
	E_2	5,000	10	150	4	4,200	1,950	3,000	2,000	484	1,044	1,472	100,000	29,250	129,250	88	179	1	15	10	179,000	E_2
F	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,385	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	F_1	4,000	10	200	3	7,467	1,260	3,000	1,600	315	506	1,579	80,000	18,900	98,900	62	126	1	5	2	126,000	F_1
	F_2	3,000	10	150	4	4,200	1,386	3,000	1,200	346	742	712	60,000	20,790	80,790	113	230	2	6	0	230,000	F_2
G	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	G_1	5,000	12	250	2	14,000	2,021	3,000	2,000	505	451	2,044	100,000	30,315	130,315	64	131	1	6	2	131,000	G_1
	G_2	5,000	14	250	2	14,000	3,209	3,000	2,000	802	614	1,584	100,000	48,135	148,135	93	182	1	16	5	182,000	G_2
H	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	H_1	4,000	12	250	2	14,000	1,702	3,000	1,600	425	380	1,595	80,000	25,530	105,530	66	134	1	6	10	134,000	H_1
	H_2	3,000	14	250	2	14,000	2,283	3,000	1,200	571	437	792	60,000	34,245	94,245	119	243	2	8	7	243,000	H_2
I	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	I_1	5,000	12	250	3	9,333	2,021	3,000	2,000	505	677	1,818	100,000	30,315	130,315	72	147	1	9	5	147,000	I_1
	I_2	5,000	14	250	4	7,000	3,209	3,000	2,000	802	1,228	970	100,000	48,135	148,135	152	310	3	2	0	310,000	I_2
K	A	5,000	10	250	2	14,000	1,170	3,000	2,000	292	313	2,395	100,000	17,550	117,550	49	100	1	0	0	100,000	A
	K_1	5,000	12	225	3	8,333	2,245	3,000	2,250	561	751	1,438	112,500	33,675	146,175	102	208	2	1	8	208,000	K_1
	K_2	5,000	14	200	4	5,600	40,12	3,000	2,500	1,003	1,535	0	...	...	...	...	...		...		...	K_2

efficient is 200, will be £1 2s., being an increase of 10 per cent., and the charge by ship B_2, of the same size, but of which the co-efficient is 150, will be £1 6s. 5d., being an increase of 32 per cent., as compared with the rate of freight by ship A, of which the co-efficient is 250.

The comparative freight charges on 100,000 tons of goods by the vessels A, B_1, B_2, respectively, would be £100,000, £110,000, and £132,000.

Seeing, therefore, that variations of the type of form, as indicated by variations of the co-efficient of dynamic performance, even within the limits of 250 and 150, which are of ordinary occurrence in steam shipping, affect the expenses incidental to the conveyance of mercantile cargo under the conditions referred to, and consequently affect the rate of freight to the extent of 32 per cent., the co-efficient of dynamic performance which a ship may be capable of realising, being thus (*cæteris paribus*) a criterion of the economic working of the ship with reference to power, becomes a highly important matter for directorial consideration in the purchasing or disposal of steam ships.

SECTION C.—Freight as affected (*cæteris paribus*) by variations in the working economy of the engines with reference to coal.

The relative working economy of marine engines as respects the consumption of coal per indicated horse-power per hour is evidently an important element for consideration as affecting freight, to illustrate which, it has been assumed that variations in mercantile practice extend from 2lbs. per indicated horse-power per hour to 4lbs. The consumption of so little as 2 lbs. per indicated horse-power per hour is not usually attained, but being now admitted to have been achieved, and such having become a matter of contract stipulation, it may be looked forward to as the probable future consumption on board ship generally, although the ordinary consumption of existing steamers cannot at the present time be rated at less than 4lbs. per indicated horse-power per hour.

By reference to the table (Section C), it appears that under the special conditions of the service under consideration (namely vessels of 5,000 tons displacement employed on a passage of 3,000 nautical miles, and steaming at the speed of 10 knots an hour) by increasing the consumption of coal from 2lbs. to 4lbs. per indicated horse-power per hour, the expense per ton of goods conveyed becomes increased in the proportion of 49 to 56, that is, in the proportion of 100 to 114, being an increase of 14 per cent., or, assuming the freight by the standard ship A, consuming 2lbs. of coal per indicated horse-power per hour, to be at the rate of £1 per ton of cargo conveyed, the rate of freight by ship C_1, consuming 3lbs. per indicated horse-power per hour, will be £1 1s. 2d., being an increase of 6 per cent., and the rate of freight by ship C_2, consuming 4lbs. per indicated horse-power per hour, will be £1 2s. 10d., being an increase of 14 per cent. per ton of goods conveyed under the conditions referred to.

The comparative freight charges on 100,000 tons of goods by the vessels A, C_1, C_2, respectively, would be £100,000, £106,000, and £114,000.

SECTION D.—Freight charge as affected (*cæteris paribus*) by variations in the constructive weight of hull with reference to the size of the ship as determined by the load displacement.

To illustrate this matter it has been assumed that the weight of hull, including the whole equipment complete for sea (exclusive of engines, coal, and cargo) may vary from 40 per cent. of the load displacement to 60 per cent., under which limitations, by reference to table (Section D), it appears that under the special conditions of the service under consideration, by increasing the weight of hull from 40 per cent. of its displacement to 60 per cent., and assuming the cost of the hull to be in proportion to its weight of materials, the expenses or freight charge per ton of cargo conveyed become increased in the proportion of 49 to 120, that is, in the proportion of 100 to 245, being an increase of 140 per cent., or, assuming the freight charge by the standard ship A, of which the weight of hull is 40 per cent. of the load displacement (2,000 tons) to be at the rate £1 per ton of goods conveyed, the rate of freight by ship D_1, of which the weight of hull is 50 per cent. of the load displacement (2,500 tons) will be £1 10s. 7d. per ton, being an increase of 53 per cent. and by ship D_2, of which the weight of hull is 60 per cent., of the load displacement (3,000 tons), the rate of freight becomes £2 9s. per ton, being an increase of 145 per cent. per ton of goods conveyed under the conditions referred to.

The comparative freight charges on 100,000 tons of goods by the vessels A, D_1, D_2, respectively, would be £100,000, £153,000, and £245,000.

Hence, in the construction of steam ships we see the importance of quality of material and excellence of fastening as a means of reducing weight, and the disadvantage that attends heavy-built ships, such as war steamers, for discharging mercantile service. Hence also we see the deficient steaming endurance of high-speed armoured ships, unless built of enormous size, as measured by their load displacement.

SECTION E.—Freight is affected (*cæteris paribus*) by variations in the constructive type of form combined with variations in the working economy of the engines.

By reference to the Table (Section E), it appears, under the special conditions of the service under consideration, that by an inferior type of form as indicated by the co-efficient of performance being reduced from 250 to 150, combined with an inferior construction of engines, as indicated by the consumption of fuel being increased from 2 lbs. to 4 lbs. per indicated horse-power per hour, thereby reducing the co-efficient of dynamic duty (column 7) from 14,000 to 4,200, the expense or freight charge per ton of goods conveyed becomes increased in the ratio of 100 to to 179, being an increase of 79 per cent.; or, assuming the freight charge by the standard ship A, of which the co-efficient of performance is 250 and rate of consumption 2lbs. per indicated h.-p. per hour (giving a co-efficient of dynamic duty 14,000) to be at the rate of £1 per ton of goods conveyed, the rate of freight by ship E_1, of which the co-efficient of performance is 200, and consumption of coals 3 lbs. per indicated horse-power (co-efficient of dynamic duty 7,467) becomes £1 4s. per ton, being an increase of 20 per cent., and by ship E_2, of which the co-efficient of performance is 150, and the consumption of coal at the rate of 4 lbs. per indicated horse-power per hour, (co-efficient of dynamic duty 4,200), the rate of freight becomes £1 15s. 10d., being an increase of 79 per cent. per ton of goods conveyed under the conditions referred to. The comparative freight charges on 100,000 tons of goods by the vessels A, E_1, E_2, respectively, would be £100,000, £120,' 00, and £179,000.

Hence, in the control of steam shipping, we see the importance of the co-efficient of dynamic duty (column 7), as indicating the economic efficiency of the ship in a mercantile point of view, with reference to the merits of her hull and engine-construction being made a subject of contract stipulation.

SECTION F.—Freight as affected (*cæteris paribus*) by variations in the size of the ship, combined with variations in the constructive type of form and in the working economy of the engines.

By reference to the Table (Section F), it appears, under the special conditions of service under consideration, that by the size of the ship being reduced from 5,000 tons displacement to 3,000 tons displacement, combined with an inferior type of form, as indicated by the co-efficient of performance being reduced from 250 to 150, and an inferior construction of engine, as indicated by the consumption of coals being increased from 2 lbs. to 4 lbs. per indicated h.p. per hour, the expense or freight charge per ton of goods conveyed becomes increased in the ratio of 49 to 113, that is in the ratio of 100 to 230, being an increase of 130 per cent., or, assuming the freight by the standard

ship A of 5,000 tons, of which the co-efficient of performance is 250, and the consumption of coal at the rate of 2 lbs. per indicated horse-power per hour, to be at the rate of £1 per ton of goods conveyed, the rate of freight by ship F_1 of 4,000 tons, of which the co-efficient of performance is 200 and the consumption of coal at the rate of 3 lbs. per indicated horse-power per hour, will be £1 5s. 2d., being an increase of 26 per cent., and by ship F_2 of 3,000 tons displacement, of which the co-efficient of performance is 150 and the consumption of coal at the rate of 4 lbs. per indicated horse-power per hour, the rate of freight becomes £2 6s., being an increase of 130 per cent. per ton of goods conveyed under the conditions referred to.

The comparative freight charges on 100,000 tons of goods by the vessels A, F_1, F_2, respectively, would be £100,000 £126,000, and £230,000.

SECTION G.—Freight as affected (*cæteris paribus*) by variations of the steaming speed at which it is required that the service shall be performed.

It is proposed to illustrate this most important elemental consideration by reference to rates of speed within the range of present practice, namely, from 10 to 14 knots per hour.

By reference to the Table (Section G), it appears that, under the special conditions of the service under consideration, by increasing the speed from 10 to 12 knots per hour, the expense or required rate of freight per ton of goods conveyed becomes increased in the ratio of 49 to 64, that is, in the ratio of 100 to 131, being an increase of 31 per cent.; and by increasing the speed from 10 to 14 knots, the expense, or required rate of freight per ton of goods, becomes increased in the ratio of 49 to 93, that is, in the ratio of 100 to 182, being an increase of 82 per cent. Hence, assuming the freight by the standard ship A, of 5,000 tons, making a passage of 3,000 nautical miles, at 10 knots per hour, to be at the rate of £1 per ton weight of goods conveyed, the rate of freight by ship G_1, steaming at 12 knots per hour, will be required to be £1 6s. 2d. per ton weight of goods conveyed, and the rate of freight by ship G_2, steaming at 14 knots per hour, will be required to be £1 16s. 5d. per ton of goods conveyed. The comparative freight charges on 100,000 tons of goods, by the vessels A, G_1, G_2, steaming at 10, 12, and 14 knots per hour respectively, would be £100,000, £131,000, and £182,000.

Hence we see how onerous are the obligations which usually impose on mail packets a rate of speed higher than that which would be adopted for prosecuting a purely mercantile service; and as no service can be permanently and satisfactorily performed which does not pay, it follows that the inadequacy, if any, of a high-speed postal subsidy must be made up by surcharge on passengers and cargo, and is, therefore, *pro tanto*, a tax upon trade.

SECTION H.—Freight as affected (*cæteris paribus*) by variations of the size of ships combined with variations of steaming speed.

We will suppose the size of ships to be 5,000, 4,000, and 3,000 tons displacement, and the steaming speed to be at the rates of 10 knots, 12 knots, and 14 knots per hour respectively.

By reference to the table (Section H), it appears that, under the special conditions of the service under consideration, by reducing the size of the ship from 5,000 to 4,000 tons, and increasing the speed from 10 to 12 knots per hour, the expense or required freight charge becomes increased in the ratio of 49 to 66, that is, in the ratio of 100 to 134, or 34 per cent.; and, by reducing the size of ship from 5,000 to 3,000 tons, and increasing the speed from 10 knots to 14 knots, the required freight charge becomes increased in the ratio of 49 to 119, that is in the ratio of 100 to 243, being an increase of 143 per cent., or a multiple of $2\frac{1}{2}$ times nearly. Hence, assuming the rate of freight by the standard ship A of 5,000 tons, steaming at 10 knots, to be at £1 per ton weight of goods conveyed, the required rate of freight by ship H_1 of 4,000 tons, steaming at 12 knots, will be £1 6s. 10d., and the required rate of freight charge by ship H_2, steaming at 14 knots per hour, will be at the rate of £2 8s. 7d. per ton weight of goods conveyed.

The comparative freight charges on 100,000 tons of goods by the vessels A, H_1, H_2, respectively, will be £100,000, £134,000, and £243,000.

SECTION I.—Freight as affected by variations of speed combined with variations of the working economy of the engines.

Assuming the rate of speed to be 10 knots, 12 knots, and 14 knots, and the consumption of coal to be 2 lbs., 3 lbs., and 4 lbs. per indicated horse-power per hour respectively, by reference to the Table (Section I.), it appears that by increasing the speed from 10 knots to 12 knots an hour, and the rate of consumption of coal being also increased from 2 lbs. to 3 lbs. per indicated horse-power per hour, the required freight charge becomes increased in the ratio of 49 to 72, that is, in the ratio of 100 to 147, or 47 per cent.; and by increasing the speed from 10 knots to 14 knots per hour, and the rate of consumption of coal being also increased from 2 lbs. to 4 lbs. per indicated horse-power per hour, the required freight charge becomes increased in the ratio of 49 to 152, that is, in the ratio of 100 to 310, being an increase of 210 per cent., or more than trebled. Hence, assuming the expense or required freight charge by the standard ship A, steaming at 10 knots per hour, and consuming 2 lbs. coal per indicated horse-power per hour, to be at the rate of £1 per ton of goods conveyed, the required freight charge by ship I_1, steaming at 12 knots an hour and consuming 3 lbs. of coal per indicated horse-power per hour, will be at the rate of £1 9s. 5d. per ton of goods, and the required freight charge by ship I_2, steaming at 14 knots per hour and consuming 4 lbs. of coal per indicated horse-power per hour, will be at the rate of £3 2s. per ton of goods conveyed. The comparative freight charges on 100,000 tons of goods by the vessels A, I_1, I_2, respectively, would be £100,000, £147,000, and £310,000.

Hence we see how onerous are the obligations of increased speed, if attempted to be performed with engines of inferior construction, as respects economy of fuel.

SECTION K.—Freight as affected (*cæteris paribus*) by variations of the speed, combined with variations in the type of form, working economy of the engines, and weight of hull.

The object of this section is to show the effect, even of small differences, of practical construction, when operating collectively to the detriment of a ship, combined with the obligation of increased speed.

By reference to the Table (Section K) it appears, that under the special conditions of the service under consideration, by increasing the speed from 10 to 12 knots, with a ship of inferior type of form, as indicated by the co-efficient of performance being reduced from 250 to 225, and of inferior engine-arrangement, as indicated by the consumption of fuel being increased from 2 to 3 lbs. per indicated horse-power per hour, the weight of hull being also increased 5 per cent., namely, from 40 per cent. to 45 per cent. of the constructor's load displacement; by this combination, the expense per ton of goods conveyed becomes increased in the proportion of 49 to 102, that is in proportion of 100 to 208, being an increase of 108 per cent., or more than doubled; or, assuming the freight by the standard ship A, to be at the rate of £1 per ton, the rate of freight by ship K_1, under the differences above referred to, becomes £2 1s. 8d., and it is to be observed that if the speed be increased to 14 knots, whilst at the same time the co-efficient of performance is reduced to 200, the consumption of fuel increased from two to four lbs. per indicated horse-power per hour, and the weight of the hull increased 10 per cent., namely, from 40 per cent. of the load displacement to 50 per cent., under these conditions the entire load displacement of the ship K_2 will be appropriated by the weight of the hull, engines, and coal, leaving no displacement whatever available for cargo, that is to say,

the vessel K_2 is utterly unable to perform the conditions of the service as a mercantile steamer.

The comparative freight charges on 100,000 tons of goods by the vessels A and K_1 respectively would be £100,000 and £208,000.

As respects the relation which subsists between the dynamic properties of vessel A, taken as the standard of comparison in the foregoing sections, and the dynamic properties of mercantile steam ships generally at the present time, it might be regarded as invidious to refer to and particularise the actual performances of vessels presently employed on commercial service, but it may be affirmed generally that the ocean performance of mercantile steam fleets does not average a co-efficient of economic duty by the formula $\frac{V^3 D^{\frac{2}{3}}}{W}$ exceeding 5,600, whilst modern naval architecture and engineering has practically shown that with certain types of form the co-efficient of performance may be expected to vary from 250 to 300, and that some engines of modern construction have consumed only from 2 lbs. to 2½ lbs. of coal per indicated horse power per hour, thus practically constituting a possible co-efficient of economic duty as high as 14,000, which has therefore been assigned to ship A in the foregoing table, and whereby, under the conditions of the service referred to, viz., ships of 5,000 tons displacement steaming at 10 knots per hour on a passage of 3,000 miles, the conveyance of goods per ton weight may be expected to be performed at fully 30 per cent. less cost than would be necessarily incurred under the same circumstances by vessels of the same size, but of which the co-efficient of economic duty does not exceed 5,600, and this comparative difference would be greatly exceeded if the size of ships be reduced, the length of passage increased, or the speed accelerated.

From the foregoing statements it appears that public interests in the great matter of FREIGHT demand that steam ships only of the most effective construction, as respects hull and engines, be employed on mercantile service. Bad types of hull and wasteful engines necessarily, as we have seen, enhance freight, increase the cost of production, and consequently curtail consumption, thus constituting a blight on national industry. A check on these evils, highly conducive to the gradual reduction of freight expenses by steam ships, would at once be instituted by making it a matter of *contract stipulation*, that a definite co-efficient of DYNAMIC DUTY, by the formula $\frac{V D^{\frac{2}{3}}}{W}$, should be realised on test trial of the ship, at the builder's load displacement and steaming at the stipulated speed. Unquestionably, for years past, in our popular marine engineering, prejudice and expediency have retarded progress; marine engineering practice has not duly availed itself of the established truths and science of the times; expansion, superheating, and surface condensation, now being reanimated as the basis of modern improvements, are but the legacies of a by-gone age hitherto neglected.

It is only by directing public opinion to bear on such subjects of general interest, that any prevalent evil can be corrected; and surely an appeal on the important subject of "freight," as affected by differences in the dynamic properties of steam ships, cannot be more appropriately made to any public body than to the British Association, under the presidency of a man especially distinguished and honoured in the path of practical science, and assembled at Manchester, the birth place of free trade, and the manufacturing capital of the world.

CHAS. ATHERTON,
Chief Engineer, H.M. Dockyard, Woolwich.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Thirty-first Annual Meeting of this Association commenced on Wednesday, the 4th of September, at Manchester. The following is a summary of the proceedings of the Association, continued from last week:—

In the sections the following papers were read:—

ON THURSDAY, SEPTEMBER 5th.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President's Address.

Warren De la Rue—Report on the Progress of Celestial Photography since the meeting at Aberdeen.

J. H. Gladstone—On the Distribution of Fog round the British Isles.

C. W. Siemens—On an Electric Resistance Thermometer, with balancing coil.

Thomas Sutton—On a Panoramic Lens.

Daniel Vaughan—Cases of Planetary Instability, indicated by the appearance of Temporary Stars.

William Vivian.—Observations on the Structure of Copper, as seen with a microscope.

Charles Tomlinson—On Lightning Figures.

SECTION B.—CHEMICAL SCIENCE.

1. Opening Address by the President.
2. Report on the Manufactures of the South Lancashire District.
3. Dr. Andrews—On the Effect of Great Pressure combined with Cold on the Six Non-condensible Gases.
4. Dr. Joule and Professor W. Thomson—On the Thermal Effects of Elastic Fluids.

SECTION C.—GEOLOGY.

Opening Address of the President, Sir R. I. Murchison.

E. W. Binney—Sketch of the Geology of Manchester.

W. Pengelly—On the Recent Encroachments of the Sea on the Shores of Torbay.

James Yates—On the Excess of Water in the Region of the Earth about New Zealand; its Causes and Effects.

Charles Moore—Notes on Two Ichthyosauri, to be exhibited to the Meeting.

J. G. Marshall—On the Relation of the Eskdale Granite at Black Comb to the Schistose Rocks.

SECTION D.—ZOOLOGY AND BOTANY.

Professor Owen, F.R.S.—On the Vertebræ of the Mole, *Talpa europœa, L.*

Professor Owen, F.R.S.—On some Objects of Natural History, from the Collection of M. Du Chaillu.

Professor Wyville Thomson, LL.D.—Observations on the Development of *Synapta inhœrens.*

J. Gwyn Jeffreys, F.R.S.—Exhibition Specimens of the *Sphœnotrochus borealis* of Fleming, from Zetland.

Dr. Ogilvie—Report of the Dredging Committee on the North and East Coasts of Scotland.

Dr. Thomas Alcock—On the Anatomical Characters of *Cypræa.*

M. T. Masters, F.L.S.—On the Relation between Pinnate and Palmate Leaves.

Dr. Dickie—Report on the Flora of the North of Ireland.

SUB-SECTION D.

George Robinson, M.D.—On the Connection between the Functions of Respiration and Digestion.

Edward Smith, M.D., F.R.S., and J. R. Milner, Esq.—Report on the influence of prison dietary and punishments upon the bodily functions of prisoners.

Professor H. Müller—On the existence and arrangement of the fovea centralis retinæ in the eyes of animals.

Charles Kidd, M.D.—On chloroform accidents, and some new physiological facts as to their explanation and removal.

John Davy, M.D., F.R.S.—On the action of lime on animal matter.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

By the President—On the Connexion between Ethnology and Physical Geography.

Major-General Sir H. C. Rawlinson, K.C.B.—On the Direct Overland Telegraph from Constantinople to Kurrachi.

James Ramsay, Esq.—Remarks on the Proposal to Form a Ship Canal between East and West Loch Tarbert, in Argyllshire.

Louis Kr. Daw, of Christiania—On the Ethnology of Finnmark, in Norway.

SECTION F.—ECONOMICAL SCIENCE AND STATISTICS.

T. Bazley, M.P.—A Glance at the Cotton Trade.

Alderman Neild—On the Price of Printing Cloth and Upland Cotton from 1812 to 1860.

John Strang, LL.D.—On the Altered Condition of the Embroidery Manufacture of Scotland and Ireland since 1857.

Henry Ashworth—On the Connection and Improvements in Cotton Bleaching, with Improvements in the Condition of the Factory Population.

Professor Rogers, M.A.—Prices in England, 1582-1620, and the effect of the American Discoveries upon them during that Period.

SECTION G.—MECHANICAL SCIENCE.

The President of the Section delivered the Opening Address.

Mr. Oldham—Report on Progress of Steam Navigation at Hull.

Mr. Atherton—On Freight as affected by difference in the Dynamic Performance of Steam Ships.

Dr. Crace Calvert—On some Woods employed in the Navy

At 8 o'clock a *Soirée* was held in the Free-Trade Hall; the chief feature of the evening was a large display of miscroscopes.

FRIDAY, SEPTEMBER 6TH.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

J. Glaisher—Report on Luminous Meteors.

W. Von Haidinger—An attempt to explain the earlier Physical Condition of Meteorites, as well as some of the phenomena attending their fall on our planet.

R. P. Greg—Observations on the preceding communication.

J. P. Gassiot—On the deposit of the Metal which takes place from the Negative terminal of an Induction Coil during the Electrical Discharge in vacuo.

B. Price—On the apparent Path of a Projectile, as affected by the Rotation of the Earth.

W. Spottiswoode—On the Canonical Form of the Decadic Binary Quantic.

W. Spottiswoode—On Petzval's Asymptotic method of solving Differential Equations.

J. Alexander Davies—Observations on the production of Colour by the Prism; the passive mental Effect or Instinct in comprehending the enlargement of the Visual angle and other optical problems.

John Smith—The Chromascope, and what it reveals.

John Smith—The Prism and Chromascope.

John Smith—An Experiment; being an attempt to illustrate the Roseate Phenomena seen during a total eclipse.

SECTION B.—CHEMICAL SCIENCE.

The President—Exhibited some Photographs of different spectra, and read a paper on the subject.

Dr. J. H. Gladstone—On the emission and absorption of rays of Light by certain Gases.

Dr. J. H. and Mr. G. Gladstone—On an Aluminous Mineral from the Upper Chalk near Brighton.

Dr. Crace Calvert—On the Chemical Composition of some Woods employed in the Navy.

Dr. Crace Calvert—On the Chemical Composition of Steel.

Dr. W. Roberts—On the solvent powers of weak and strong solutions of alkaline carbonates on Uric Acid Calculi.

Dr. Smith (of Sydney)—On certain difficulties in the way of separating Gold from Quartz.

SECTION C.—GEOLOGY.

Professor Owen—On a Dinosaurian Reptile (*Scelidosaurus Harrisoni*) from the Lower Lias of Charmouth.

Professor Owen—On the remains of a Plesiosaurian Reptile (*Plesiosaurus Australis*) from the Oolitic formation in the Middle Island of New Zealand.

Harry Seely—On the Elsworth Rock and of the Clay above it.

Professor Harkness—On the Sandstones and their associated deposits of the Valley of the Eden and the Cumberland Plain.

Rev. W. S. Symmonds—On some Phenomena connected with the Drifts of the Severn, Avon, Wye, and Usk.

George W. Morton—On the Pleistocene Deposits of the District about Liverpool.

Professor Phillips—Notice of some Facts in Relation to the Post-glacial Gravels of Oxford.

SECTION D.—ZOOLOGY AND BOTANY.

J. Gwyn Jeffreys—Report of the results of Deep Sea Dredging in Zetland, with a notice of several species of Mollusca, new to science or to the British Isles.

Rev. A. M. Norman—Some results of Deep Sea Dredging in Zetland.

Dr. Collingwood and S. Byerley—Preliminary Report of the Committee for Dredging the Mersey and the Dee.

R. Macandrew—Report of the General Dredging Committee.

P. L. Sclater—Report of the present state of our knowledge of the species of the Apteryx, living in New Zealand.

P. L. Sclater—Preliminary Report on the present state of our knowledge of the terrestrial Vertebrata of the West Indies.

Dr. Daubeny—On the influence exerted by Light on the Functions of Plants.

Dr. Daubeny—On a Violet peculiar to the Calamine Rocks in the neighbourhood of Aix la Chapelle.

Dr. Daubeny—On the Functions discharged by the Roots of Plants.

Rev. T. Hincks—Notes on the Ovicells of the Polyzoa, with reference to the views of Professor Huxley.

SUB-SECTION D.

James Turnbull, M.D.—On the Physiological and Medicinal Properties of Sulphate of Aniline, and its use in the Treatment of Chorea.

E. Smith, M.D., F.R.S., and J. R. Milner, Esq.—Report of the Influence of Prison Dietary and Punishments upon the Bodily Functions of Prisoners. Part Second.

Joseph Toynbee, Esq., F.R.S.—The Action of the Eustachian Tube in Man, as Demonstrated by Dr. Politzer's Otoscope.

John Davy, M.D., F.R.S.—On the Blood of the Common Earthworm

George Rolleston, M.D., F.R.S.—On certain points in the Anatomy of the Insectivora.

Professor Remak—Upon the Influence of the Sympathetic Nerve on Voluntary Muscles, as witnessed in the Treatment of Progressive Muscular Atrophy by Secondary Electric Currents.

Lionel Beale, M.B., F.R.S.—On the Structure and Growth of the Elementary Parts (cells) of Living Beings.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

Henry Wise, Esq.—Remarks on a proposed Railway across the Malay Peninsula.

Captain Cameron, H.B.M. Consul at Massonah—Notices on the Ethnology, Geography, and Commerce of the Caucasus.

P. B. Du Chaillu, Esq.—On the Geography and Natural History of Western Equatorial Africa.

James Hunt, Ph.D., F.S.A.—On the Acclimatisation of Man.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

The President delivered the opening Address (adjourned from yesterday).

David Chadwick.—On the Progress of Improvements in Manchester and Salford during the last twenty years.

J. Watts, Ph. D.—On Strikes.

Edmund Potter, F.R.S.—On Co-operation and its Tendencies.

Daniel Stone, F.C.S.—On the Rochdale Co-operative Societies.

Rev. W. R. Thorburn, M.A.—Co-operative Stores: Their Bearing on Athenæums, &c.

Rev. W. N. Molesworth—On the Progress of Co-operation at Rochdale.

SECTION G.—MECHANICAL SCIENCE.

J. Scott Russell, F.R.S.—Report of the Committee on Steam Ship Performance.

James Heywood, M.A., F.R.S.—Report of the Committee on the Patent Laws.

Mr. Hughes—Resolutions passed at a Meeting of the Manchester Patent Law Reform Association, held August 30th, 1861.

Sir W. G. Armstrong, F.R.S.—On the Patent Laws.

Thomas Webster, F.R.S.—On Property in Inventions, and its effect on Arts and Manufactures.

R. A. Macfie—On Patents, considered internationally.

W. Spence—On Patent Tribunals.

At 8 o'clock a *Soirée* took place in the Free-Trade Hall; a discourse was delivered by Professor Miller, M.D., F.R.S., King's College, London, "On the Spectrum Discoveries of Bunsen and Kirschoff.

SATURDAY, SEPTEMBER 7TH.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Gen. Sabine—Provisional Report on the Magnetic Survey of Great Britain.

G. T. Stoney—On the Amount of Direct Magnetic Effect of the Sun or Moon upon Instruments at the Earth's Surface.

The President—On the Laws of the Principal Diurnal Inequalities, Solar and Lunar, of Terrestrial Magnetic Force, as deduced from Ten Years' Observations at Greenwich, and on their apparent causes.

The President—On Spontaneous Terrestrial Galvanic Currents.

Prof. Hennessey—On a Probable Cause for the observed Diurnal Variation of Dip and Declination.

Rev. E. Hincks—On the Quantity of the Acceleration of the Moon's Mean Motion, as indicated by the Records of certain Ancient Eclipses.

Rev. H. Lloyd—On the Secular Changes of Terrestrial Magnetism, and their connexion with Disturbances.

Archibald Smith and F. J. Evans—On the Effect produced on the Deviations of the Compass by the Length and Arrangement of the Compass Needles.

J. J. Sylvester—On the Involution of Axes of Rotation.

A. Cayley.—On Curves of the Third Order.

M. Bierens de Haan—On Definite Integrals.

SECTION B.—CHEMICAL SCIENCE.

Dr. Moffat.—On Atmospheric Ozone.

Dr. Moffat.—On Sulphuretted Hydrogen as a Product of Putrefaction.

Professor Galloway—On the Composition and Valuation of Superphosphates.

Professor Delffs—On Morin, and the Non-existence of Moro-tannic Acid.

Professor Anderson—On the Constitution of Paranaphthaline or Anthracine, and some of its Decomposition Products.

G. C. Foster—On Piperic and Hydropiperic Acids.

SECTION C.—GEOLOGY.

W. Pengelly—On a New Bone-Cave at Brixham.

T. W. Barrow—Remarks on the Bone-Caves of Craven.

W. Whincopp.—On the Red Crag Deposits of the County of Suffolk.

W. H. Baily—Palæontological Remarks on the Silurian Rocks of Ireland.

A. B. Wynne—On the Geology of Knockshigowna, County Tipperary.

Robert Scott, M.A.—On the Granite Rocks of Donegal, and the Minerals associated therewith.

T. A. Readwin—On the Gold of North Wales.

Dr. Hagen—Comparison of Fossil Insects of England and Bavaria.—Communicated by Mr. Stainton.

SECTION D.—ZOOLOGY AND BOTANY.

H. Fawcett—On the Method of Investigation pursued by Mr. Darwin, in his Treatise on the Origin of Species.

Dr. Collingwood—A Scheme to induce the Mercantile Marine to aid in the Advancement of Science, by the intelligent Collection of Objects of Natural History.

L. H. Grindon—On the Flora of Manchester.

Dr. G. Gibb—On the arrest of Puparial Metamorphosis of *Vanessa antiopa*.

Dr. J. Cleland—On the Anatomy of *Orthagoriscus mola*.

A. Stansfield—On new British Species of *Bleçhnum*.

SUB-SECTION D.

Lionel Beale, M.B., F.R.S.—On the Structure and Growth of the Elementary Parts (cells) of Living Beings.

John Davey, M.D., F.R.S.—On the Question whether the hair is or is not subject to Sudden change in Colour.

B. W. Richardson, M.D.—Physiological Researches on Resuscitation.

Prof. Rolletson, M.D., F.L.S.—On some Points in the Anatomy of Insectivora.

A. Hancock—On certain Points in the Anatomy and Physiology of the Dibranchiate Cephalopods.

R. Garner, Esq.—Observations on the Encephalon in Mammalia.

Chas. Robinson, Esq.—On the Occipital Vertebra in Osseous Fishes.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

Professor Owen, F.R.S., &c.—On the Osteology and Dentition of the Natives of the Andaman Islands.

A Letter from the Colonial Office, on the Exploration of N.W. Australia, under Mr. Gregory.—Communicated by Sir R. I. Murchison.

Sir R. I. Murchison—An Appeal on behalf of the only son of the great traveller, Thomas Atkinson, Esq., F.R.G.S.

A Letter from Sir Hercules Robinson, Governor of Hong Kong, relating to the progress of Major Sard, Captain Blackiston, and others, who are endeavouring to pass from China to the North of India.—communicated by Sir R. I. Murchison, V.P.R.G.S.

Dr. Beke, F.R.G.S.—On the Mountains forming the Eastern side of the Basin of the Nile, and the Origin of the Designation, "The Mountains of the Moon;" with a Notice of a Recent Volcanic Eruption in the Red Sea.

P. O'Callaghan, Esq., B.A., Sec. of Philosophical Society of Leeds—Cromleachs and Rocking Stones considered Ethnologically.

Bath C. Smart, Esq.—Remarks on the English Gipsies and their Dialects.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

John Shuttleworth—Some Account of the Manchester Gasworks.

Miss Twining—On the Employment of Women in Workhouses.

Colonel Sykes, M.P., F.R.S.—Notes on the Progress and Prospects of the Trade of England with China since 1833.

Frederick Purdy—On the Relative Pauperism in England, Scotland, and Ireland, 1851—1860.

William Westgarth—The Commerce and Manufactures of the Colony of Victoria.

William Farr, M.D., D.C.L., F.R.S.—On the Recent Improvements in the Health of the British Army.

J. T. Danson—On the Growth of the Human Body in Height and Weight in Males from 17 to 30 years of age.

SECTION G.—MECHANICAL SCIENCE.

Dr. Eddy—Proposal for a Class of Gun Boats capable of engaging Armour Plated Ships at Sea; accompanied with suggestions for fastening on Armour Plates.

Capt. Blakeley—Artillery *versus* Armour.

Wm. Fairbairn, F.R.S. (The President of the Association)—Results of Experiments on Targets, at Shoeburyness.

E. J. Reed—On the Iron Cased Ships of the British Admiralty.

Theo. Aston—On Enlarged Projectiles for Rifled Firearms.

At 8 o'clock a *Soirée* was held in the Free-Trade Hall, where a magnificent display of telegraphic instruments was collected and shown in action. A discussion upon the collection was delivered by W. R. Grove, Q.C., F.R.S.

MONDAY, SEPTEMBER 9.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

The Astronomer Royal commenced the business of the Section by making remarks on Dr. Hinck's Paper, on Saturday, on the acceleration of the Moon's Mean Motion, as indicated by records of ancient Eclipses.

Fleeming Jenkin—On Permanent Thermo-electric Currents in Circuits of one Metal.

Sir David Brewster—On Binocular Lustre.

Report from the Balloon Committee.

Professor Hennessy—Provisional Report on the present state of our knowledge as to the Transmission of Sound Signals during Fogs at Sea.

Professor Hennessy—On the connection between Storms and Vertical Disturbances of the Atmosphere.

J. Glaisher—On a Deep Sea Pressure Guage—On a Deep Sea Thermometer—On a Daily Weather Map—On Admiral Fitzroy's Paper presented to Section A, relative to the Royal Charter Storm—On some Meteorological Documents relating to Mr. Green's Balloon Ascents.

W. Hopkins—On the Theories of Glacial Motion.

E. J. Lowe—On the Great Cold of Last Christmas, and its Destructive Effects.

Sir David Brewster—On the Compensation of Impressions Moving Over the Retina.

Sir David Brewster—On Photographic Micrometers.

C. W. Siemens—On the Bathometer—an Instrument to Indicate the Depth of the Sea, without Submerging a Line.

Balfour Stewart—On the Photographic Records given at the Kew Observatory of the great Magnetic Storm of the end of August and the beginning of September, 1859.

Balfour Stewart—On the New Mininum Mercurial Thermometer proposed by Mr. Casella.

SECTION B.—CHEMICAL SCIENCE.

Professor Tomlinson—On the cohesion figures of Liquids.

Dr. Voelcker—Report on field experiments and laboratory researches on the Constituents of Manures essential to Cultivated Crops.

Dr. Voelcker—On the Composition of Crystallised Moroxite, from Gumillo, near Alicante.

J. B. Lawes, F.R.S., and Dr. J. H. Gilbert, F.R.S.—On some points in connection with the Exhaustion of Soils.

H. Deane—On a Particular Decomposition of Ancient Glass.

Dr. Wallace—On the Composition and Properties of the Water of Loch Katrine, as supplied to Glasgow.

Dr. Stevenson Macadam—On the Proportion of Arsenic present in Paper-hangings.

Dr. Stevenson Macadam—On the Proportion of Tin present in Tea Lead.

SECTION C.—GEOLOGY.

Sir R. I. Murchison—Exhibited Maps and Sections recently published by the Geological Survey.

Sir R. I. Murchison—Communicated the Results of the Geological Survey of Tasmania, by C. Gould, with Maps.

Henry Green.—On the Faults of the Lancashire Coalfield.

Edward Hull—On Isometric Lines, and the relative distribution of the Calcareous and Sedimentary Strata of the Carboniferous Rocks.

Prof. Harkness—On the Old Red Sandstone of South Perthshire.

Rev. Dr. Anderson—Report on Dura Den.

A. Bryson—On the Aqueous Origin of Granite.

W. Pengelly—On the Age of the Dartmoor Granites.

SECTION D.—ZOOLOGY AND BOTANY.

P. P. Carpenter—Notes on the Variations of *Tecturella grandis*.

P. P. Carpenter—On the Cosmopolitan Operations of the Smithsonian Institution.

Dr. J. E. Gray—Letter in reference to the death-wound of the large Gorilla recently purchased from M. Du Chaillu by the Trustees of the British Museum.

H. T. Stainton—On a New Mining-larva recently discovered.

Rev. T. Hincks—On the Development of the Hydroid Polyps, *Clavatella* and *Staurıdea*; with remarks on the relation between the Polyp and its Medusoid, and between the Polyp and the Medusæ.

J. Couburn—On the Culture of the Vine in the Open Air.

W. Danson—On Barraguta Cotton from the Plains of the Amazon, and on the Flax-fibre Cotton of North America.

SUB-SECTION D.

R. Garner—Observations on the Encephalon of Mammalia.

Dr. Mouat—On Prison Dietary.

Professor Hyrtl—On Nerves without end; communicated by Dr. Percival Wright.

Professor Hyrtl—On the Pneumatic Processes of the Occipital Bone; communicated by Dr. Percival Wright.

Professor Hyrtl—On portions of Lungs without Blood-vessels; communicated by Dr. Percival Wright.

Professor Rolleston—On some points in the Anatomy of Insectivora.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

John Crawfurd, Esq., President—On the Antiquity of Man, from the Evidence of Language.

R. Cull—On the Antiquity of the Aryan Languages.

Rutherford Alcock, C.B., F.R.G.S., H.B.M. Minister in Japan.—Journey in the Interior of Japan, with the Ascent of Fusiyama.

R. Wollaston, M.D.—On some Account of the Romans in Britain.

Col. Shaffner, U.S.—Spitzbergen Current, and Active and Extinct Glaciers in South Greenland.

W. P. Snow—On the Geological Science of Arctic Explorations, and the Advantage of Continuing it.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

William Newmarch, F.R.S.—On the Extent to which Sound Principles of Taxation are embodied in the Legislation of the United Kingdom.

Professor J. E. T. Rogers, M.A.—On the Definition and Incidence of Taxation.

C. E. Macqueen—The True Principles of Taxation.

W. Clarke, M.D.—On a Revision of National Taxation.

Rev. Canon Richson, M.A.—The Income Tax.

Richard Valpy.—The Commercial Relations between England and France.

H. J. Ker Porter—To present Engravings of Farm Labourers Cottages, with a Specification, and a Few Remarks in continuation of a Paper read at Oxford in 1860.

Mrs. Fison.—On Sanitary Improvements.

Rev. W. Caine—Ten Years' Statistics of the Mortality amongst the Orphan Children taken under the care of the Dublin Protestant Orphan Societies.

Charles Thompson—On some Exceptional Articles of Commerce and Undesirable Sources of Revenue.

SECTION G.—MECHANICAL SCIENCE.

Charles Vignoles, F.R.S.—On Iron Construction, with remarks on the Strength of Iron Columns and Arches. By F. W. Shields.

B. H. Stoney.—On the Deflection of Iron Girders.

Edward T. Bellhouse—On the Applications of the Hydraulic Press.

John Robinson—On the Application of Workshop Tools to the Construction of Steam-Engines and other Machinery.

W. B. Johnson—On the Application of the Direct-Action Principle.

Professor Macquorn Rankine—On the Resistance of Ships.

At three o'clock the General Committee met, W. Fairbairn, Esq., F.R.S., in the chair, for the purpose of fixing the place of meeting for next year, electing the President, and other business of the Association. Cambridge was selected as the place of meeting for next year, and the Rev. Robert Willis, F.R.S., Jacksonian Professor of Natural Philosophy in that University, was chosen to fill the office of President. In the evening, at 8 o'clock, G. B. Airy, Esq., F.R.S., Astronomer Royal, announced a discourse, in the Free-Trade Hall, "On the Solar Eclipse of last year."

TUESDAY, SEPTEMBER 10TH.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Balfour Stewart—Report on the Theory of the Exchanges of Heat.

Robert Mallet—Report on Earthquake Wave Experiments.

Professor H. J. S. Smith—Report on the Theory of Numbers.

Sir D. Brewster—On the Optical Study of the Retina.

J. S. Stuart Glennie—On the Application of the Principle of the Conservation of Force to the Mechanical Explanation of the Correlation of Forces.

J. S. Stuart Glennie—On the Resistance of the Ether to the Comets and Planets, and on the Rotation of the latter.

Professor Phillips.—Notes of Sketches of Parts of the Surface of the Moon.

W. R. Birt—Contributions to the Report on Selenography.

Rev. T. Rankin—Meteorological Observations.

W. S. Jevons—On the Deficiency of Rain in an Elevated Rainguage, as caused by Wind.

The President of the Association—Remarks on the Temperature of the Earth's Crust, as Exhibited by Thermometrical Returns obtained during the Sinking of the Deep Mine at Dukinfield.

Isaac Ashe—On the Causes of the Phenomena of Cyclones.

Dr. Morgan—On a New Registering Anemometer, invented by Dr. Morgan.

P. J. Livsey—On the New Barometer invented by Mr. R. Howson.

SECTION B.—CHEMICAL SCIENCE.

J. J. Griffin, F.C.S.—On the Construction of Gas-burners for Chemical use.

Professor Roscoe—On Perchloric acid and its hydrates.

W. H. Hurst—Note on the Sulphur compound formed by the action of Sulphuretted Hydrogen on Formiate of lead at a high temperature.

Drs. Russell and Matthiessen—On vesicular structure in Copper.

W. Gossage—On the History of the Alkali Manufacture.

Dr. Daubeny—On the Evolution of Ammonia from Volcanoes.

Drs. Williamson and Russell—On an Apparatus for the Rapid Separation and Measurement of Gases.

J. Mercer—On Madder Photographs.

Professor Tennant—On a specimen of Meteoric Iron from Mexico.

Dr. J. H. Lloyd—On purifying towns from Sewage by means of dry Cloacæ.

Dr. Stevenson Macadam—On an economical mode of boiling Rags, &c., with alkaline ley.

Dr. Voelcker—On the action of Rennet on Milk.

Dr. Voelcker—On natural combinations of Phosphates with Alkalies.

Wm. Marriott—On the separation of Ammonia from Coal Gas.

SECTION C.—GEOLOGY.

J. W. Salter—On the Nature of Sigillariæ, and on the Bivalve Shells of the Coal.

Dr. Hector—On the later Changes in the Physical Geology of British North America, with Notes on the Auriferous Drifts of the Pacific Slope.

Dr. Hector—On the Age and Distribution ef the Mesozoric Coal of the Pacific Coast and Saskatchewan Prairies.

David Milne Home—Notice of Elongated Ridges of Drifts, common in the South of Scotland, called *Kains*.

T. A. Readwin—On the Gold of North Wales.

J. T. Wilkinson and J. Whitaker—On the Burnley Coal Field and its Fossil Contents.

W. Patterson—On Certain Markings in Sandstones.

Rev. C. R. Gordon—On the Laws Discoverable as to the formation of Land on the Globe.

SECTION D.—ZOOLOGY AND BOTANY.

Dr. Jessen—Notice of the Absorbing power of the Roots of Plants.

A. Hancock—On certain points in the Anatomy and Physiology of the Dibranchiate Cephalopods.

Tuffen West—On some point of Interest in the Structure of Spiders.

P. L. Sclater—Remarks on the late increase in our knowledge of the Struthious Birds.

Rev. A. R. Hogan—On *Daphina Schaefferi* and other Freshwater Crustacea.

Rev. H. H. Higging—On the Arrangement of Hardy Herbaceous Plants adopted in the Botanic Gardens, Liverpool.

T. M. Mitchell—On the Migration of the Herring.

C. W. Peach—Report on the Herring Fishery.

SUB-SECTION D.

Dr. Cleland—On a method of Craniometry, with Observations on the varieties of form of the Human Skull.

Dr. Ed. Smith, F.R.S.—On the Influence of the Season of the Year on the Human System.

Professor Rolleston—On the Anatomy of Pteropus.

Professor Rolleston—On the Homologies of the Lobes of the Liver in Mammalia.

Dr. Richardson—Physiological Researches on the Artificial Production of Cataract.

Dr. J. D. Morrel—The Physieal and Physiological Processes involved in Sensation.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

Sir E. Belcher—Remarks on the Glacial Movements noticed in the vicinity of Mount St. Elias, on the North-west Coast of America.

P. B. Du Chaillu—On the People of Western Equatorial Africa.

Rev. A. Hume, D.C.L., LL.D.—On the Relations of the Population in Ireland, as shown by the Statistics of Religious belief.

Henry Duckworth, F.R.G.S.—On the New Route to Western China.

James Hector — M.D., F.R.S.— On the Capabilities for Settlement of the central parts of British North America.

Hon. J. Baker, F.R.G.S.—On Australia, including the recent Explorations of Mr. Macdonald Stuart.

Wm. Bollaert, F.R.G.S.—The great Earthquake at Mendoza, 20th March, 1861.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

James Heywood, F.R.S.—On the Inspection of Endowed Educational Institutions.

Captain Donnelly, R.E.—On the Government System of Examinations in Science.

J. T. Hammack, F.S.S.—On the General Results of the Census of the United Kingdom in 1861.

John Strang, LL.D.—Comparative Progress of the English and Scottish Population, as shown by the Census of 1861.

T. A. Welton—An Examination of the Increase and Decrease of Population in England and Wales, 1851-61.

R. H. Bakewell, M.D., M.R.C.S.—On the Influence of Density of Population on the Fecundity of Marriages in England.

Rev. A. Hume, D.C.L.—On the Condition of National Schools in Liverpool, as compared with the Population, 1861.

Henry Fawcett, M.A.—On the Economical Effects of the Gold Discoveries.

Profesor J. E. T. Rogers, M.A.—Can Patents be defended on Economical Grounds?

Henry Ashworth—On Capital Punishments and Crime.

SECTION G.—MECHANICAL SCIENCE.

Professor James Thompson—Report of Experiments on the Gauging of Water.

Wm. Fairbain, F.R.S. (President of the Association)—On the Effects of Vibratory Action and long-continued Changes of Load upon Wrought-Iron Bridges and Girders.

David Chadwick—On Recent Improvements in Cotton Gins.

J. F. Bateman, F.R.S. (President of the Section)—On Street Pipe Arrangements for Extinguishing Fires.

C. W. Siemens—On Railway and Fire Alarms.

G. Arnott, M.D.—On the Prevention of Railway Accidents.

Col. Sir Henry James, R.E.—On Photozincography; with copies of Doomsday Book.

Mr. Haworth—On a Perambulator and Street Railway.

T. Dobson, B.A.—On Explosions in Coal Mines.

Messrs. Silver—On Telegraphic Wires.

William Tate—On Bailey's Steam Pressure Guage.

James Higgins—On Railway Brakes.

Peter Effertz—On Brickmaking Machinery.

Septimus Mason—On a Locomotive for Common Roads.

T. Symes Prideaux—On Economy in Fuel.

S. Bateson—On an Improved Feed Water Heater, for Locomotive and other Boilers.

Andrew Henderson—A.I.C.E., F.R.S.—On Steam Navigation on the Rivers and Coasts of India and China.

At 8 o'clock a *Soirée* was held in the Free-Trade Hall, when a display of natural objects was provided by the Field Naturalists Association of Manchester. A discourse, explanatory of the collection, was delivered by Edwin Lankester, Esq., M.D., F.R.S.

WEDNESDAY, SEPTEMBER 11.

SECTION A.—MECHANICAL AND PHYSICAL SCIENCES.

Latimer Clark and Sir Charles Bright—On Standards of Measurement of Electrical Quantities and Resistances.

Professor W. Thomson—Physical considerations regarding the possible Age of the Sun's Heat—Communicated by Professor Rogers.

J. W. Brown—On the supposed Connexion of Meteorological Phenomena and Magnetic Variation.

Sir W. Rowan Hamilton—On Geometrical Nets in Space

C. F. Ekman—An Enquiry into the Fundamenta Principles of Algebra, chiefly with regard to negative and imaginary quantities.

Rev. T. P. Kirkman—On Roots of Substitutions.

W. L. Russell—On the Calculus of Functions, with some remarks on the Theory of Electricity.

T. Dobson—On the Symmetrical Form of the Properties of the Plane Triangle.

T. Rose—On Presentations of Colour under novel conditions.

W. Danson—On the Laws of Universal Storms.

Rev. P. Walton—On some Signs of Changes in the Weather.

H. W. Crawley—Remarkable Phenomena observed in the Sun in Nova Scotia.

G. J. Symons—On British Rainfall.

J. T. Goddard—On the Cloud Mirror and Sunshine Recorder.

M. N. Adler—On the Almanack.

J. J. Walker—Observations on an Iris in Water near Sunset.

W. T. Shaw—Method of Interpreting some of the Phenomena of Light.

SECTION C.—GEOLOGY.

Sir R. I. Murchison—To communicate information from Haidinger, respecting the present state of the Imperial Geological Institution of Vienna.

Mr. Richardson, C.E.—On the Details of the Carboniferous Limestone, as laid open by the railway cutting and tunnel near Almondsbury, N. of Bristol—Communicated by Sir R. I. Murchison.

A. Gages—Report on Examination of Minerals.

R. Mallet.—Report of Earthquake Experiments.

Professor W. Thomas—An Examination of some Points

in the Doctrine of the Internal heat of the Globe—Communicated by Professor Rogers.

J. Bonwick—On the Extinct Volcanoes of Australia.

The concluding meeting of the Association was held in the Free-Trade Hall at 3 o'clock, W. Fairbairn, Esq., F.R.S., President of the Association, in the chair, when the proceedings of the Central Committee and the grants of money sanctioned by it were announced.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, September 6th*, 1861.]

Dated 4th July, 1861.

1705. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Imp. in the construction and arrangement of apparatus for the manufacture of ice and for the refrigeration of solid and fluid masses in general. (A com.)

Dated 11th July, 1861.

1751. J. R. Cotter, Donoughmore Rectory, Cork—Certain imp. in the pianoforte.

Dated 13th July, 1861.

1761. P. J. De Rette, 9, Rue Guimard, Bruxelles—Imp. in the manufacture of wind musical instruments in brass or other metal to which pistons are applicable.

Dated 23rd July, 1861.

1845. N. E. Dumesnil, 12, Rue aux Loups, Sotteville-les-Rouen, France—Imp. in materials for lubricating parts of machinery and for other lubricating purposes.

Dated 24th July, 1861.

1853. J. Sidebottom, Harewood, near Mottram, Cheshire—Imp. in fire-arms and ordnance.

Dated 26th July, 1861.

1875. F. N. Thurel, 4, South-street, Finsbury—Imp. in the method of fastening shoes, stays, gloves, and other wearing apparel

Dated 27th July, 1861.

1879. J. H. Johnson, 47, Lincoln's-inn-fields—Imp. in sewing machines. (A com.)

Dated 29th July, 1861.

1887. G. Sturrock, Woolwich—Imp. in the construction of breech-loading fire-arms.

Dated 1st August, 1861.

1909. B. Browne, 52, King William-street—An improved self-acting tap or apparatus for the convenient passage of lighted gas, or other illuminating fluid or liquid, and particularly adapted for lighting cigars. (A com.)

1911. R. Harrison, Port Penrhyn, Carnarvon—Imp. in apparatus for cutting slates and slabs.

Dated 2nd August, 1861.

1919. R. Benton, 5, Great College-street, Westminster—Imp. in machinery or apparatus for obtaining rotary motion by the use of the gravitating power of solid or fluid matter.

Dated 3rd August, 1861.

1933. J. Vavasseur, 28, Gravel-lane, Southwark—A new or improved transportable machine or apparatus for rifling cannon

Dated 6th August, 1861.

1949. G. Potts, Edinburgh—Imp. in the construction of elastic steel mattresses.

Dated 12th August, 1861.

2001. A. Garzend, 29, Boulevart St. Martin, Paris—A new or improved apparatus for cutting up and reducing dye and other wood.

2005. V. Jankowski, Princes-street, Fitzroy-square—Imp. in apparatus for sawing wood and other substances.

Dated 14th August, 1861.

2021. A. A. R. Damoiseau, Paris—Imp. in kilns for baking bricks, tiles, and other similar articles.

Dated 15th August, 1861.

2029. S. Carey and W. M. Pierce, East Ham, Essex—Imp. in apparatus for reburning animal charcoal.

Dated 20th August, 1861.

2065. W. Fitkin, 88, Fleet-street—Imp. in apparatus or instruments for extracting teeth.

2067. R. A. Brooman, 166, Fleet-street—An imp. in preserving meat and other animal substances. (A com.)

2071. J. Somerville, Maidstone—Imp. in apparatus for drilling and tapping gas and water mains and pipes, and in preventing leakage therefrom.

2073. T. Sutton, King's College, London—An improved camera for taking photographic portraits and instantaneous pictures.

2075. F. Gye, Royal Italian Opera, Covent Garden—Imp. in constructing gasometers and gasometer tanks.

2077. G. F. Muntz, Birmingham—Imp. in apparatus for melting metals.

Dated 21st August, 1861.

2081. T. Lambert, Great Henny, Essex—An improved agricultural implement for rolling ridges and furrows or straight work.

2083. W. Clark, 53, Chancery-lane—Imp. in optical and illuminating apparatus. (A com.)

2091. T. Green, Leeds, and R. Mathers, 18, Stoke Newington-green—Imp. in apparatus for transmitting motion to machinery.

2093. W. Richards, Birmingham—Imp. in rifles and projectiles.

Dated 22nd August, 1861.

2103. T. Richardson, Newcastle-upon-Tyne, and R. Irvine, Hurlet, Renfrewshire—Imp. in the manufacture of paper.

Dated 23rd August, 1861.

2109. W. D. Player, Birmingham—Certain imp. in the description of buttons commonly known as linen buttons.

2111. H. Ingle, Shoe-lane, and J. Ingle, Pimlico—Imp. in printing machines.

Dated 24th August, 1861.

2117. J. Cranston, Birmingham—Imp. in the construction of conservatories, orchard houses, and other horticultural erections, which imps. are also applicable to the covering of areas such as are used for drill sheds, markets, railway sheds, colonists and army huts, and many other similar purposes.

Dated 26th August, 1861.

2121. J. Clark, Glasgow—Imp. in the manufacture of envelopes and other covers, and in part applicable to the gumming of sheets of paper.

2123. G. Nye, 18, Mount-street, Lambeth—Imp. in apparatus for administering injection in a continuous stream, also applicable as an eye douche and other purposes.

2129. W. E. Newton, 66, Chancery-lane—Improved machinery for filtering liquids, decolorizing saccharine and other juices, and rectifying alcoholic liquors. (A com.)

Dated 27th August, 1861.

2133. L. M. F. Patureau, Paris—An improved thread-protecting clew box.

2135. J. C. C. Azemar, 40, Mark-lane—The manufacture of an instrument to facilitate the practice of the drum.

2137. J. H. Johnson, 47, Lincoln's-inn-fields—Imp. in dampers for stamping purposes. (A com.)

2139. J. M. Hart, 76, Cheapside, and R. Lavender, 2, Acacia-cottages, New-road, Hornsey—Imp. in handles or knobs of locks and latches, and in the means of applying them.

Dated 28th August, 1861.

2143. W. S. Guinness, New York—Imp. in sewing machines.

2145. S. Carpenter, High-street, Banbury, Oxon—Imp. in the construction of carriage wheels.

PATENTS SEALED.

[*From Gazette, September 6th*, 1861.]

September 5th.

568. Capt. G. B. V. Arbuckle and T. Scott.
569. H. A. Silver and H. Griffin.
590. T. W. Davenport and S. Cole.
591. B. Walker and W. Tilson.
596. J. C. Fisher.
602. J. T. Hutchings.
604. J. Hirst, jun., and J. Hollingworth.
605. J. Tomlinson.
608. A. Aerts.
611. W. Perry.
617. D. Hebson and W. G. Ramsden.
620. G. F. Muntz.
623. J. W. Aston.
630. C. Gammon.
645. C. Stevens.
681. M. Henry.
686. A. Wall.
695. H. A. Bartlett.
720. T. Hindle.
770. F. Chevillard.
832. A. V. Newton.
843. W. E. Newton.
851. B. Knowles.
975. J. Gjers.
1149. J. B. Jarlot.
1219. W. Smith.
1348. F. A. Whitehead.
1429. H. Turner and T. Yates.
1431. H. Turner and T. Yates.
1433. B. D. Godfrey.
1460. J. Mason.
1578. J. Faulding.
1686. J. Terry.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

[*From Gazette, September 6th*, 1861.]

September 3rd.

2005. R. A. Brooman.

[*From Gazette, September 10th*, 1861.]

September 5th.

2014. J. Fielden.
2081. L. Vidie.

September 6th.

2085. G. C. Grimes.

September 7th.

2043. C. N. Kottula.
2052. J. Knowles.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

[*From Gazette, September 6th*, 1861.]

September 3rd.

1928. G. M. Miller.